Base Realignment and Closure (BRAC) Cleanup Team Workshop

Innovative Technology

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NS Mayport
Bioslurping & Bioventing

Overview

- Implementing an innovative technolgy (Bioslurping) at NS Mayport to provide cheaper, better, and faster cleanup
- Aggressive LNAPL free product removal permits natural attenuation of dissolved phase hydrocarbons
- Cost Savings ~ $3M capital cost plus LTO $$$
- Time Savings - Estimate free product removal and soil cleanup in less than 1 to 2 years vs up to 30 years (??) for traditional methods

Area History - NS Mayport SWMU 6 & 7

- Area formed from 1925-1926 dredging cycle of the St. Johns River and Mayport Turning Basin
- Permeable materials are fine to medium grained sands or silty-sand with shell
- Water table 4’ to 9’ bls--groundwater flows toward St. Johns River (approximately 200’ north)

SWMU 6--Waste Oil Pit

- 1973--constructed in response to the Clean Water Act
- Unlined pit--0.2 acres, excavated 6 feet bls
- 1973-1978--250,000 gallons bilge water, several thousand gallons oily waste, and possibly solvents and transformer oils are allowed to seep into underlying soil
- 1978--pit filled and covered

SWMU 7--OWTP Sludge Beds

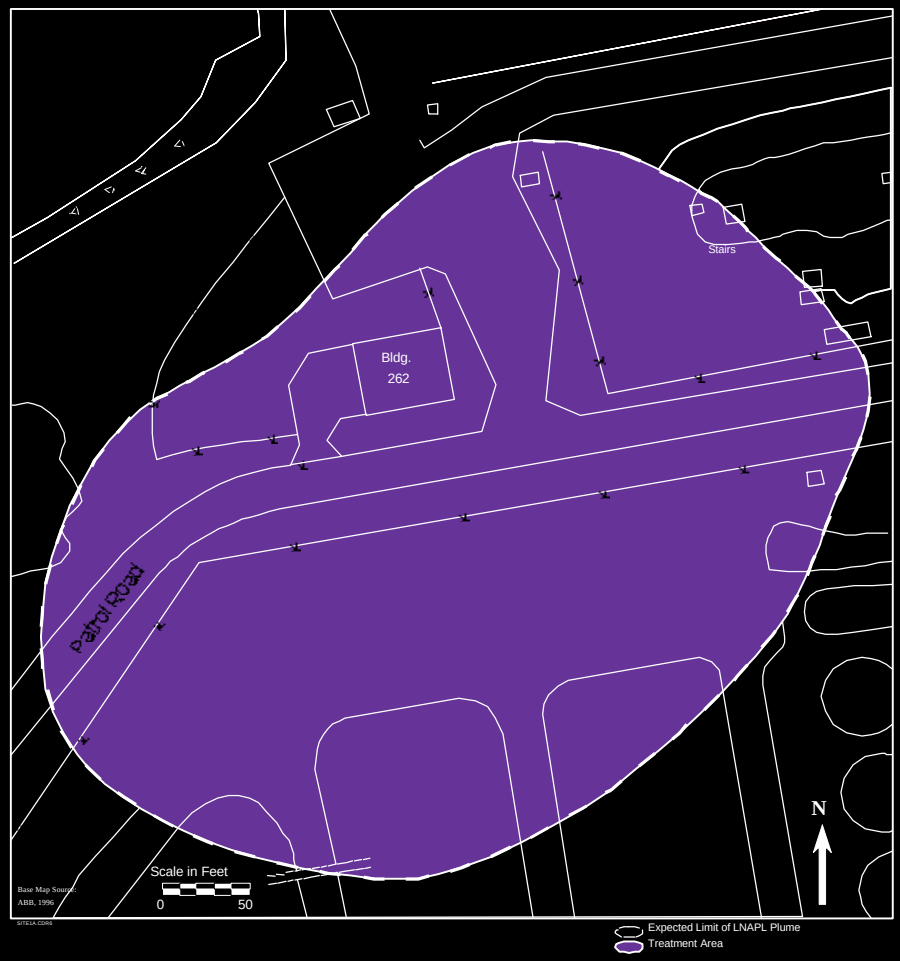
- 1978--four beds constructed (one over SWMU 6) 150’ x 50’ each
- Unlined pits--enclosed by earthen berms 8’ above surrounding land surface
- Received and dewatered sludge from OWTP clarifier and bilge water receiving tanks
- Bilge water overflow pumped directly into drying beds (when tanks at capacity)

SWMU 7--Sludge Beds (cont'd)

- 1,500 gallons of sludge per day of operation--twice per week
- No sludge taken offsite
- 1989--new bilge water receiving tanks constructed; easternmost bed excavated, lined, and sludge deposited into adjacent bed
- 1994--all beds taken out of service

SWMUs 6 & 7--Site Findings

- Heavy, aged, diesel-like petroleum contamination
- Floating, free-phase hydrocarbons measured in 6 monitoring wells downgradient of OWTP area--thickness varied over time and not always observed in two wells



IM for SWMUs 6 & 7

- Need system to prevent petroleum contaminated groundwater from reaching St. Johns River
- Patrol Road and Fuel Farm (utilities) limit technology choices
- 1994--funds obtained
- Install five 3’ diameter sumps with total fluids pumping

NELP Innovative Technology

- 1995--Award contract to demonstrate Low Temperature Thermal Desorption (LTTD) at site
- 2,400 tons petroleum contaminated soil (above the water table)
- Soil processed through LTTD rotary dryer. Petroleum substances volatilized; treated soil tested and returned to site

SWMUs 6 & 7--Soil

- CMS recommended LTTD to remediate petroleum contaminated soil (above water table) within sludge drying beds
- Estimated remediation cost for drying beds was $2.4 million (FY 96)

SWMUs 6 & 7--Groundwater

- CMS recommended installing trenches to intercept contaminated groundwater
- Pump and treat groundwater
- Estimated construction cost was $1.5 million (FY 97)
- Estimated pump and treat costs was $200,000 per year (up to 30 years)

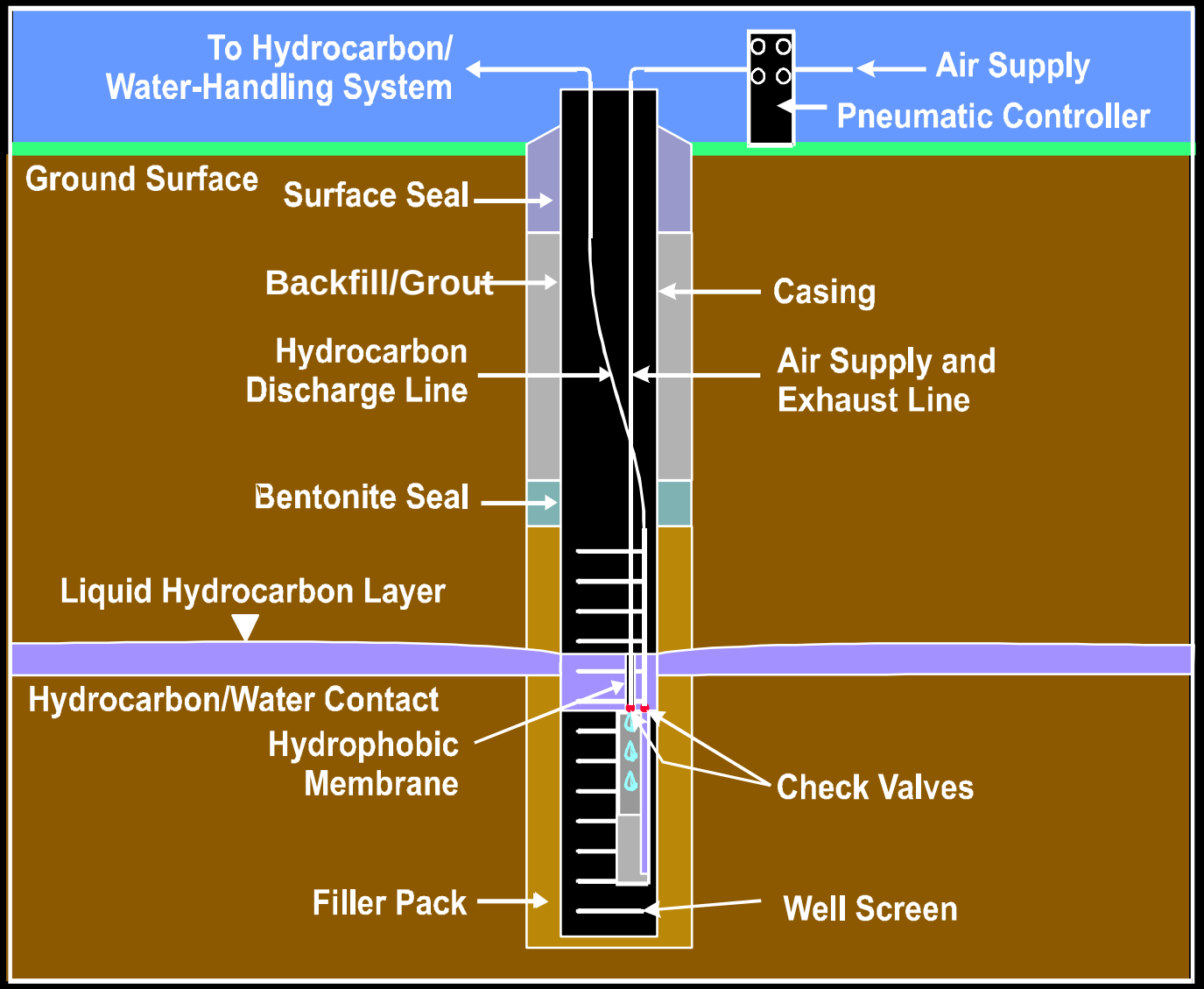
1996--Project Status

- FDEP did not approve CMS because it did not address groundwater below the drying beds.
- NS Mayport team was proceeding with LTTD award for soils.

Tiger Team--Feb 96

- Recommend Bioslurping & Bioventing
- Bioslurping is innovative, vacuum-enhanced, free-product recovery technology
- More efficient and effective than traditional methods

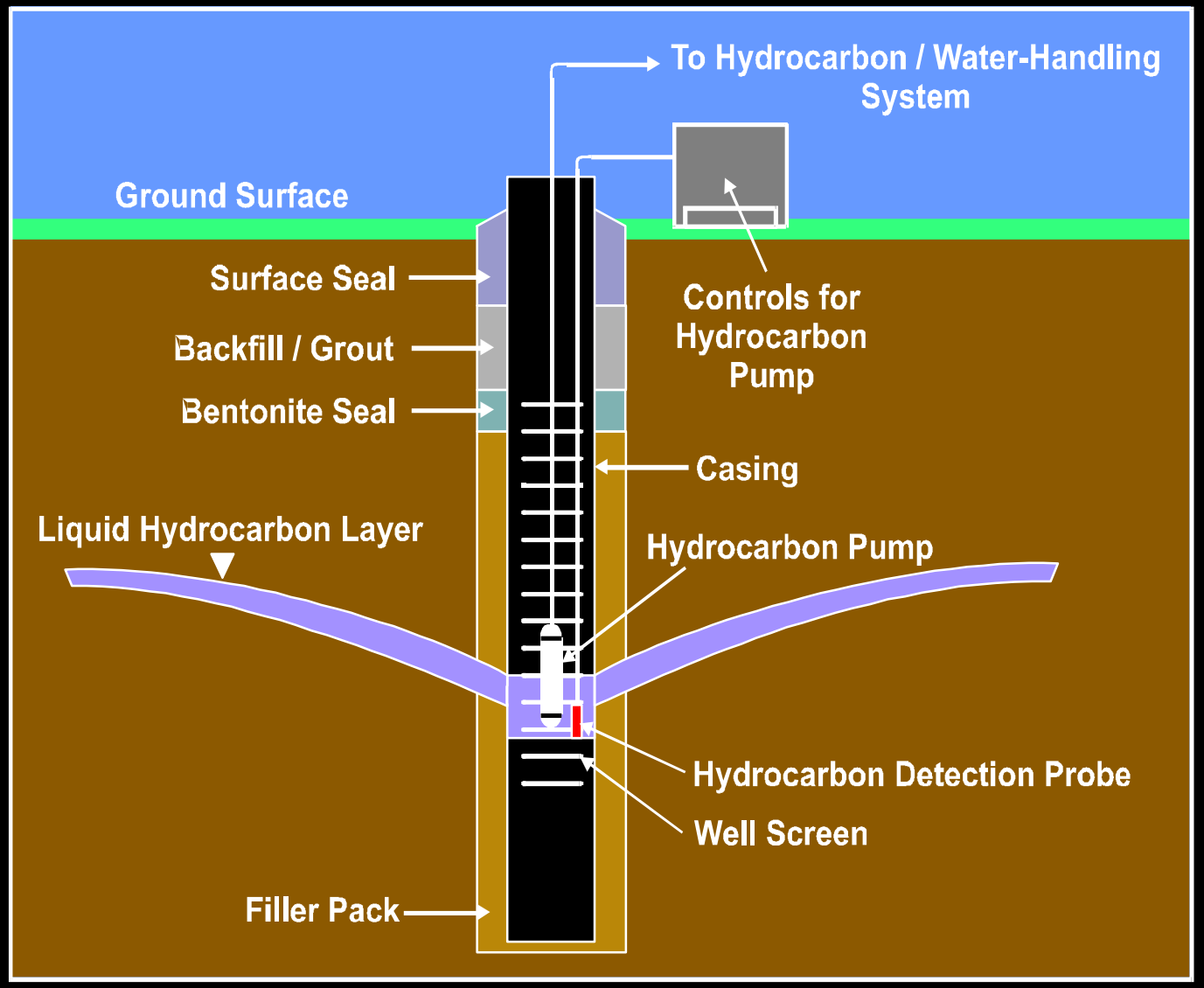
Pneumatic Skimming Pump



Skimmer Technology Limitations

- No vadose zone treatment
- Will not work at all sites
- High capital cost per well
- Down hole equipment requires maintenance

Single-Pump Drawdown



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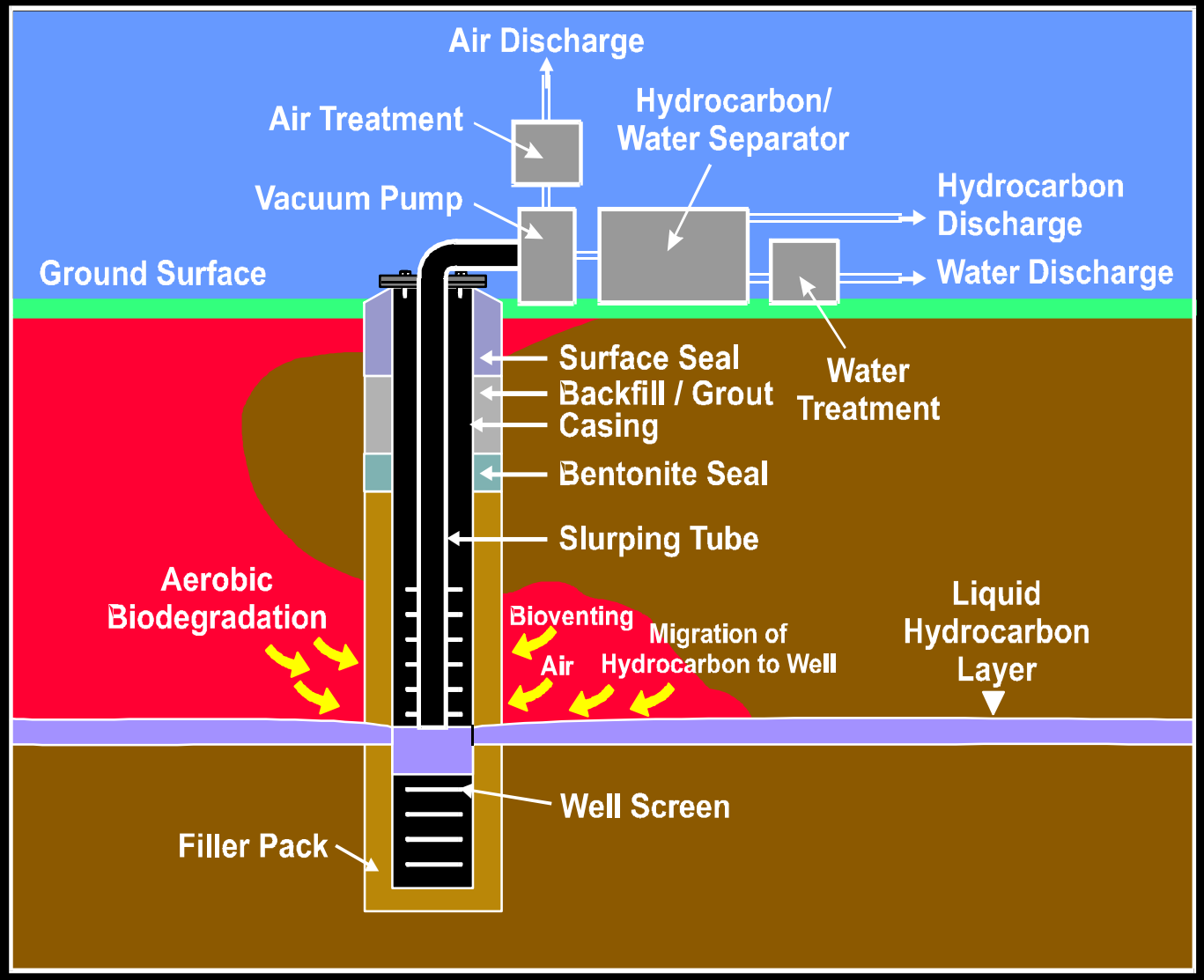
Drawdown Technology Limitations

- No vadose zone treatment
- Dependent on aquifer permeability (not feasible at many sites)
- High capital cost per well
- Extends smear zone (cone of depression)
- Often high water production rates: high cost water treatment

Bioslurper System



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Bioslurper Technology Features

- Enhanced LNAPL recovery via vacuum-enhanced pumping
- Simultaneous treatment of the vadose zone via bioventing
- Reduced ratio of groundwater extracted per gallon of fuel recovered compared to conventional dual pump recovery systems
- Can be designed to dewater to expose contamination below the water table or for hydraulic control

Bioslurper Technology Features

- Designed to require only 1 pump to extract from multiple wells, reducing capital costs compared to dual pump & skimmer technologies
- Applications possible to greater than maximum suction lift due to liquid entrainment
- Easy conversion of system to conventional bioventing system when LNAPL recovery activities are completed

Bioslurper Technology Features

- At low permeability sites may be only feasible technology
- Highly adaptable to changing site conditions
- Has been demonstrated successfully at wide range
  of sites

Bioslurper Technology Limitations

- Water and Vapor Treatment
- Operation and Maintenance
- May be less effective at deep, high permeability sites

Fuel Recovery Rates (gal/d)

	Skimmer (2d)	Bioslurper	Skimmer (1d)	Drawdown
Bolling 1	17	60	8.2	31
Bolling 2	0.86	1.1	NA	0.13
Andrews	8.7	79	0.70	NA
Wright-Patt	4.0	4.7	NA	2.5
Travis	0	3.9	0	3.8
Robins 1	11	48	5.0	12
Robins 2	1.4	3.2	NA	0.36
Kaneohe	0	2.4	0.050	0
Hickam	35	91	NA	410
Johnston Atoll	30	56	3.6	9.5

Example: CSS Panama City, Florida

- 3/4 acre site with free product at 7 feet BLS
- Fine to medium grained sand
- Pilot test with one 2" well: Recovered 12 gals/day product, 1000 gal/day water at 25 inches of water vacuum
- Full scale design: 17 - 2" diameter extraction wells spaced approx 40 feet apart based on radius of influence of approx 25 feet
- Total Cost -$580K
  - Pilot test - $60K
  - Design - 80K
  - Construction - 320K
  - O&M (1 year) - 120K

NS Mayport Team Concerns

- NS Mayport partnering team questioned applicability due to:
  - heavy, aged, diesel-like product
  - high groundwater table
  - tidally influenced groundwater
  - sandy soils (possible vacuum breaks)

Technical Support

- In-house technical support reviewed site conditions and determined actually optimal for bioslurping
- Technical support and IT RAC bioslurping expert met with RPM and partnering team
  - Site conditions and current extent of contamination
    - Free product moving toward bay
    - TPH in pits
  - New RBCA provisions addressing TPH, etc
  - Discussed concept design - bioslurping for free product & bioventing for vadose zone in pits

Bioslurping Pilot Scale

- **Summer 1996**

  Bioslurped from two existing monitoring wells

  - **installed two new wells in drying beds**

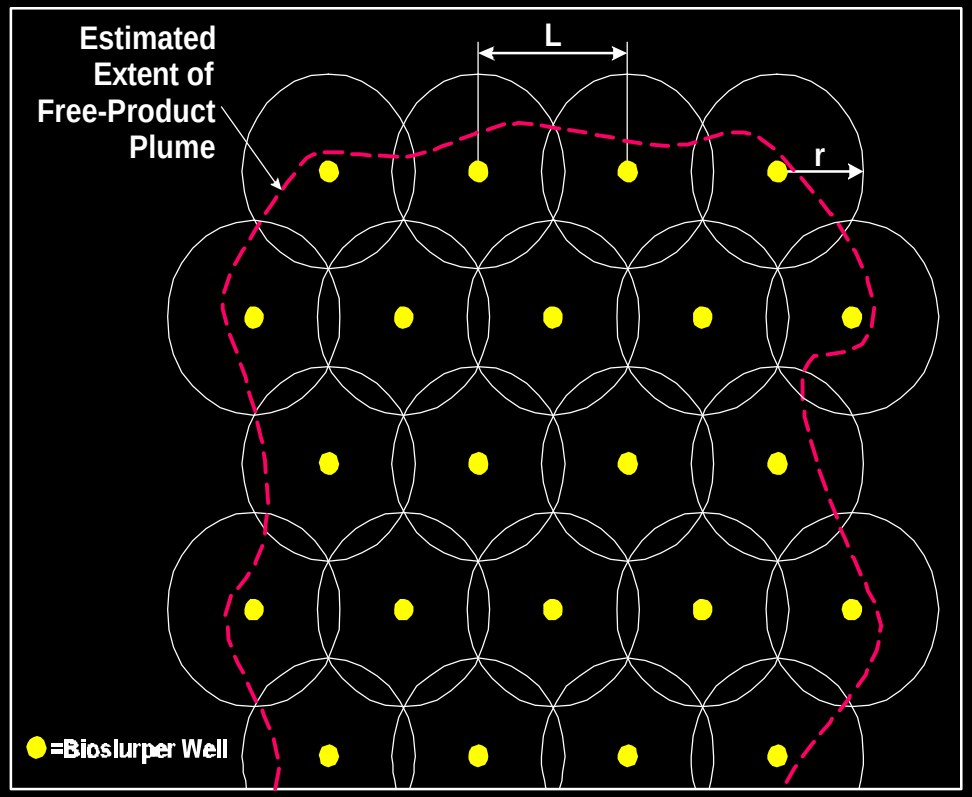
- **Objectives Met**

  - **Demonstrated enhanced biodegradation**
  - **Demonstrated that bioslurping can recover more LNAPL than existing treatment system**

- **Battelle prepares schematic work plan.**

Bioslurping Design

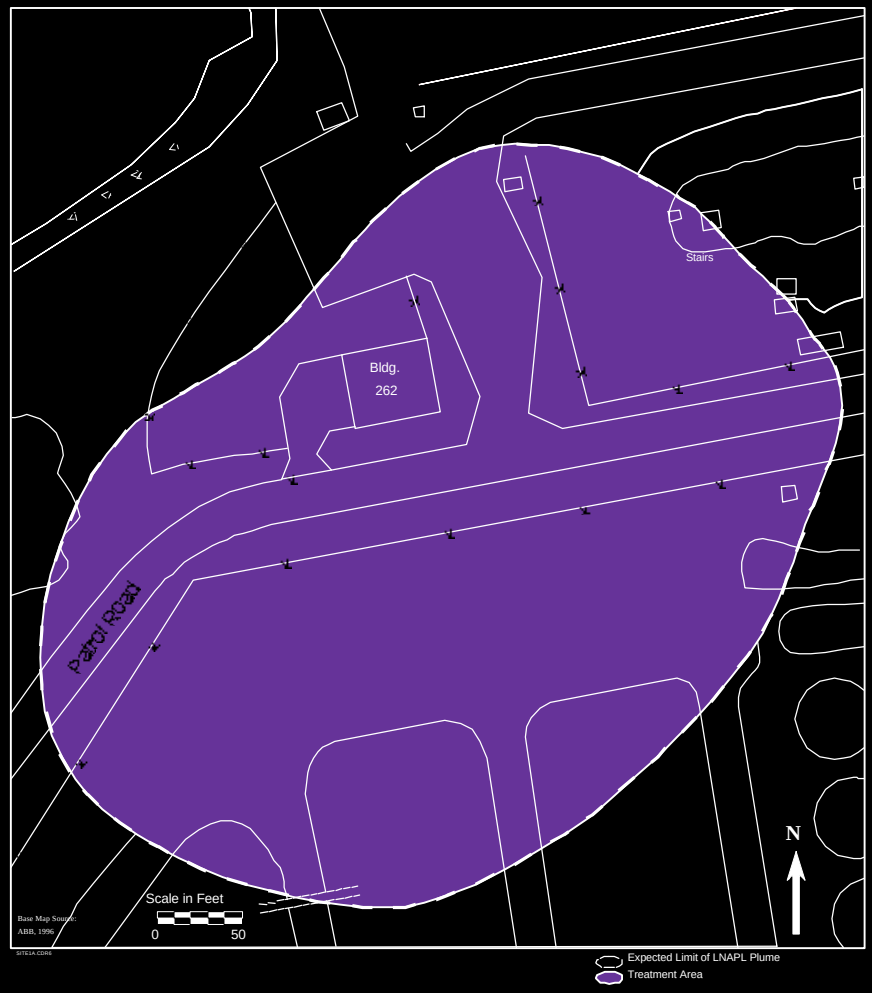
- Bioslurping wells radius of influence determined to be 30’ (outside drying beds)
- Bioslurping system includes:
  - 59 new wells
  - 11 existing monitoring wells or piezometers
  - 58 monitoring points



Bioventing Design

- **Bioventing wells radius of influence determined to be 25’ (inside drying beds.)**

- **Bioventing system includes:**
  - **40 new wells**
  - **13 monitoring points**



Trailer-mounted System

- Bechtel constructed two full-scale trailer mounted systems
  - allow use of equipment for two-hour pumping test during well installation,
  - allow equipment to be easily moved to other sites in the area, and
  - reduce demobilization costs when this site remediated.

Innovation--Direct Push Wells

- Use SCAPS to install direct push wells
- PWC JAX contracted to install wells and monitoring points
- Direct push wells installed for $350 each resulting in cost savings of over $200,000 (compared to RAC installed conventional wells)

Well Performance & Product Delineation

- Direct Push Wells installed July 1997-- immediately conducted two-hour pumping test to determine :
  - if DPWs will work
  - quantity of product at each well
- Well development required
- Monitored wells for product thickness (during next few months)

Well Performance & Product Delineation

- Analysis of monitoring data led to:
  - Average product thicknesses for each well)--three thickness ranges:
    - greater than 0.03 feet thick
    - 0.01 to 0.03 feet thick
    - less than 0.01 feet thick (NFA)

Operation Plan

- Some “bioventing” wells actually require bioslurping due to product thickness evaluation
- Approximately 30 wells have average thickness of greater than 0.03 feet--start pumping from these wells only (capture maximum product without smearing over area)
- When product levels drop at these wells, move to next level of wells for bioslurping

Full-Scale Bioslurping Results

- Bioslurping system operated for 29 out of 61 days (8 Jan - 8 Mar 98)
  - Downtime due to OWTP
  - 550 gallons free-product recovered
  - 105,000 gallons groundwater
- Two-week schedule developed for pulse operation of bioslurper extraction well networks

Bioventing Results

- Oxygen at approximately 20.5%.
- Carbon Dioxide at approximately 0.1%.
- Drying beds sufficiently aerated by bioventing and bioslurping processes.

Optimization - Off-Gas Treatment System

- Dehumidifier--lower relative humidity of vapor to between 40-50% to optimize adsorption capacity (of the GAC)
- Two 1,000-lb canisters of granular activated carbon (GAC)

Optimization - Off-Gas Evaluation

- Off-gas effluent:
  - Hydrocarbons negligible
  - TPH concentrations below detection
- Worst-case condition--discharge would be 1.9 lbs/day TPH
- FDEP allows direct discharge of less than 15 lbs/day TPH
- Goal -- Discontinue off-gas treatment

Optimization - Water Treatment

- Currently pump contaminated groundwater to OWTP for treatment
- OWTP costs = $35 per 1,000 gallons water treated
- If average 9,000 gallons liquid per day of operation--annual disposal cost would be $115,000

Optimization - Water Treatment

- Water currently stored in two 20,000 gal ASTs being used for equalization basins prior to discharge to OWTP does not have significant contaminant concentrations
- Recommend using ASTs as oil/water separators:
  - Discharge from bottom of ASTs to WWTP via sanitary sewer (WWTP costs = $5 per 1,000 gal)
  - Use oil skimmer pump to collect product from top of ASTs--local fuel-recycling agency could remove product
  - Savings ~ $100 K per year

Exit Strategy

- Bioslurping objective to remove free product to extent practicable (~ .1 inch)
  - pulse operation in zones and observe recovery
  - first at interface, then drawdown mode
  - discontinue when diminishing well recovery
- Bioventing objective - incidental treatment of vadose zone TPH while bioslurping in operation
- Monitored Natural Attenuation for dissolved phase

Benefits

- Cost Savings ~ $3M capital cost over LTTD and P&T, plus $$$ LTO
- Time Savings - Estimate free product removal in less than 1 to 2 years vs 30 years (??) LTO with interceptor trench P&T recovery/containment system
- Aggressive free product removal should permit natural attenuation of dissolved phase hydrocarbons
- Trailer-mounted bioslurper will be reused at other sites at NS Mayport and other activities in Jax area
- Transferred technology to another Navy RAC for more widespread use